



Cranfield University, UK
University of the Free State, South Africa
Mohammed VI Polytechnic University, Morocco

Fuzzy Cognitive Mapping: Learning from Small-Scale Farmers in South Africa & Morocco

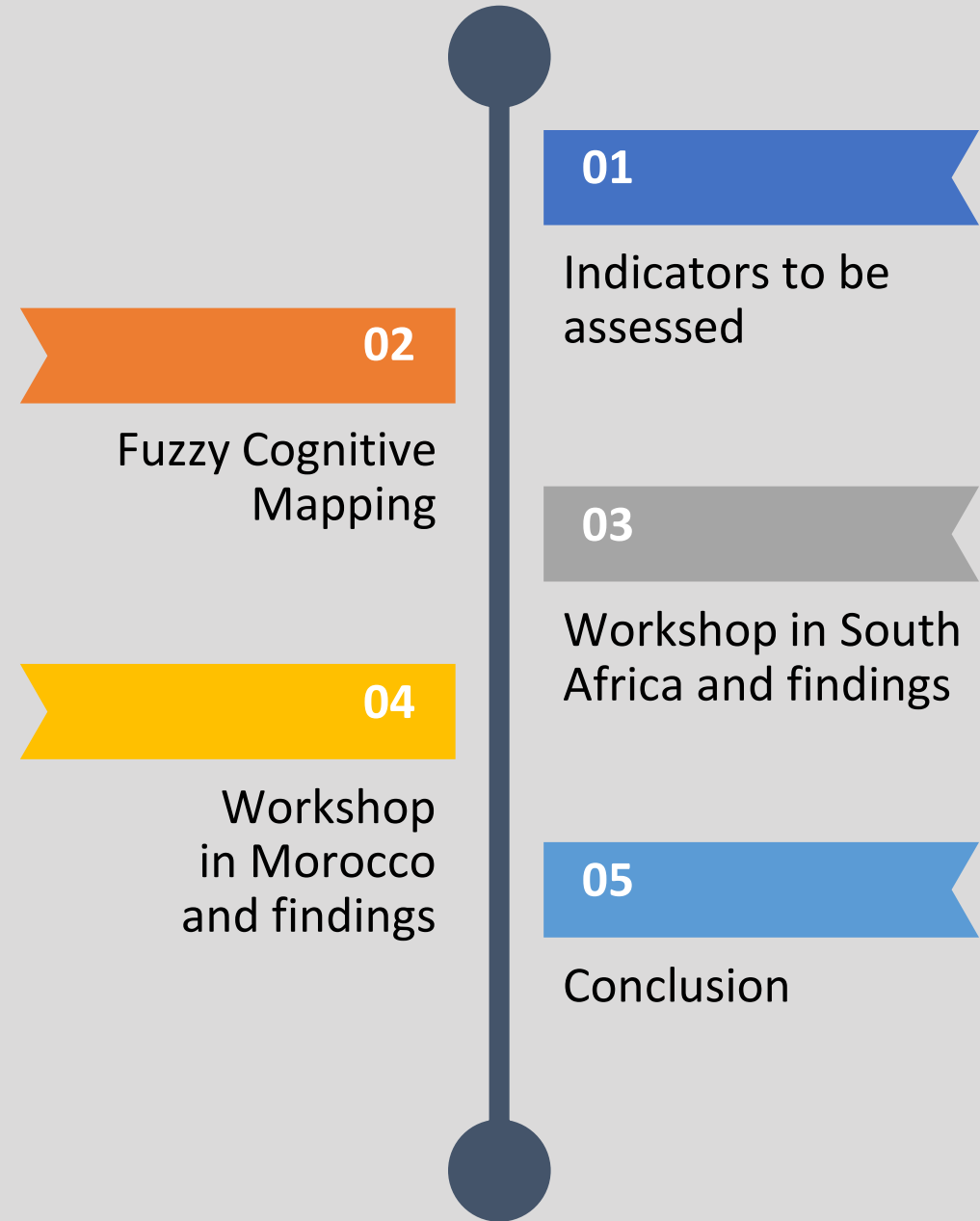
Dr Elisabeth Shrimpton and
Dr Tanaya Sarmah

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Outline














Indicators

Q1. How do the indicators interlink to **impact upon livelihoods**?

-  Loss of crops
-  Reduce levels of groundwater
-  Sale of livestock
-  Soil degradation
-  Reduced availability of nutritious food
-  Reduced water quality
-  Reduced investment in fertilisers, seeds, machinery
-  Migration away from the area
-  Increased poverty and unemployment
-  Increased gender inequality
-  Change in energy needs (more or less?)

Q2. How do the indicators interlink to influence **community's ability to adapt to droughts**?

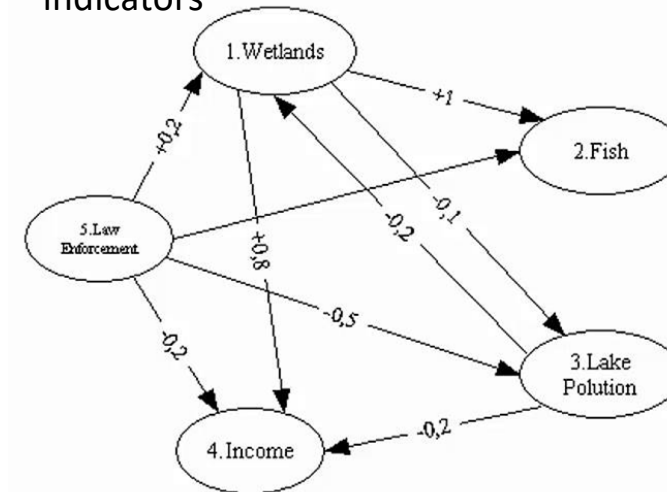
-  Government policies on drought for small farmers
-  Drought prediction and early warning systems
-  Advice and coaching on new techniques and technology
-  More water re-use or more efficient irrigation
-  Higher % of drought resistant crops cultivated
-  Access to insurance, finance or credit
-  Access to fertilisers or machinery
-  Access to (more) energy
-  Participation in local farming co-operatives
-  More local land set aside for conservation and biodiversity
-  Improved produce storage and transportation capacity

Introduction to Fuzzy Cognitive Mapping (FCM)

- FCM is a technique that captures cause-effect relationships and dynamic interactions through 'maps'. It is useful in capturing complex systems (often where data is limited).
- We used FCM to capture participants' views of the connectivity of drought indicators.
- Small-scale farmers in South Africa & Morocco participated in FCM exercise.
- The groups created maps to show Q1) drought related impacts on livelihoods and Q2) associated adaptive strategies

A fuzzy cognitive map consists of:

- Indicators (or nodes) connected through links (arrows)
- These links has a +ve or -ve polarity varying between -1 to +1 to show weak or strong link
- +ve sign indicates direct relationship between the indicators
- -ve sign indicates inverse relationship between the indicators

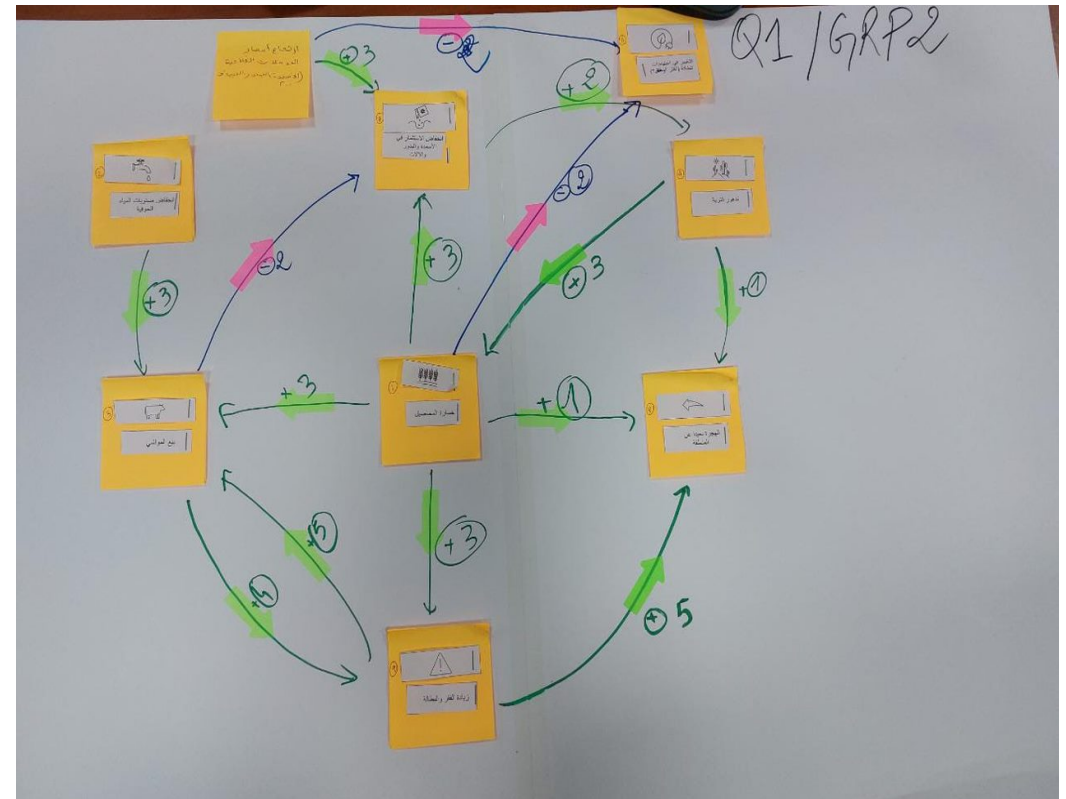


Özesmi & Özesmi (2004)

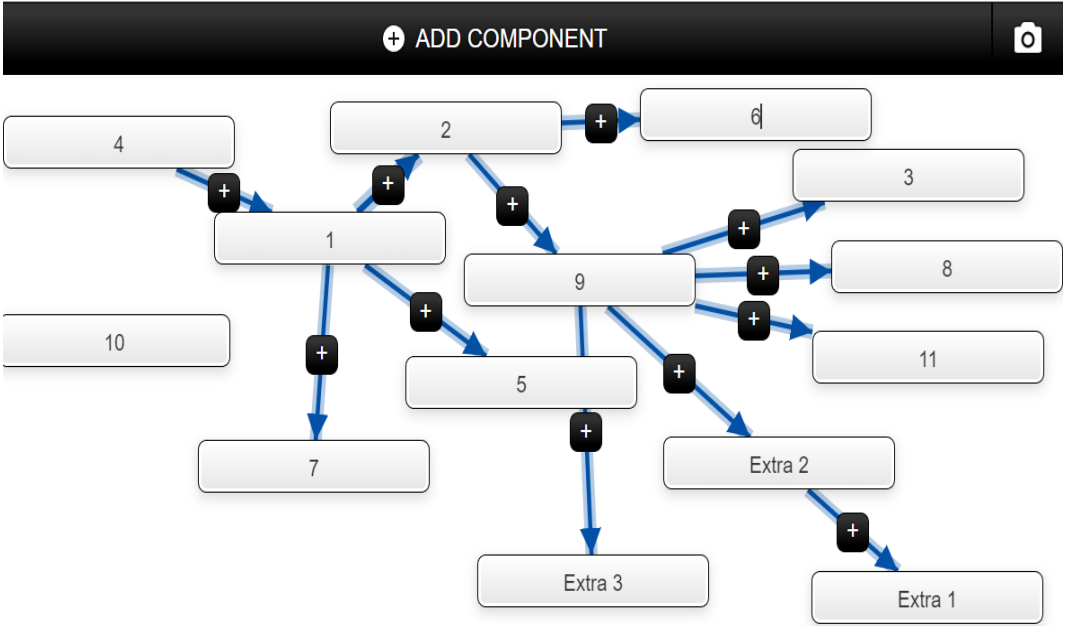
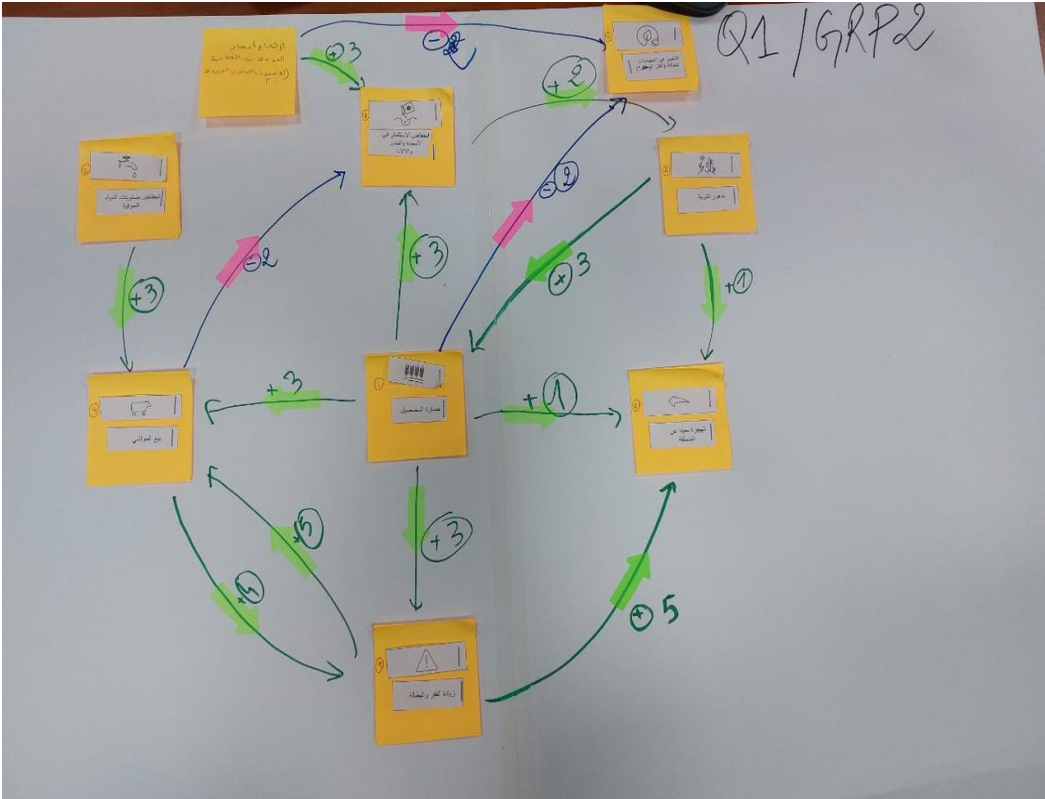
Creating an FCM

- Participating groups were given large sheets of paper to draw the maps
- Indicator icons were given on smaller cards to move around on the sheet
- Icons helped communication
- Participants linked the indicators using arrows
- Marked these links with +ve or -ve to indicate the type of relationship

- Example



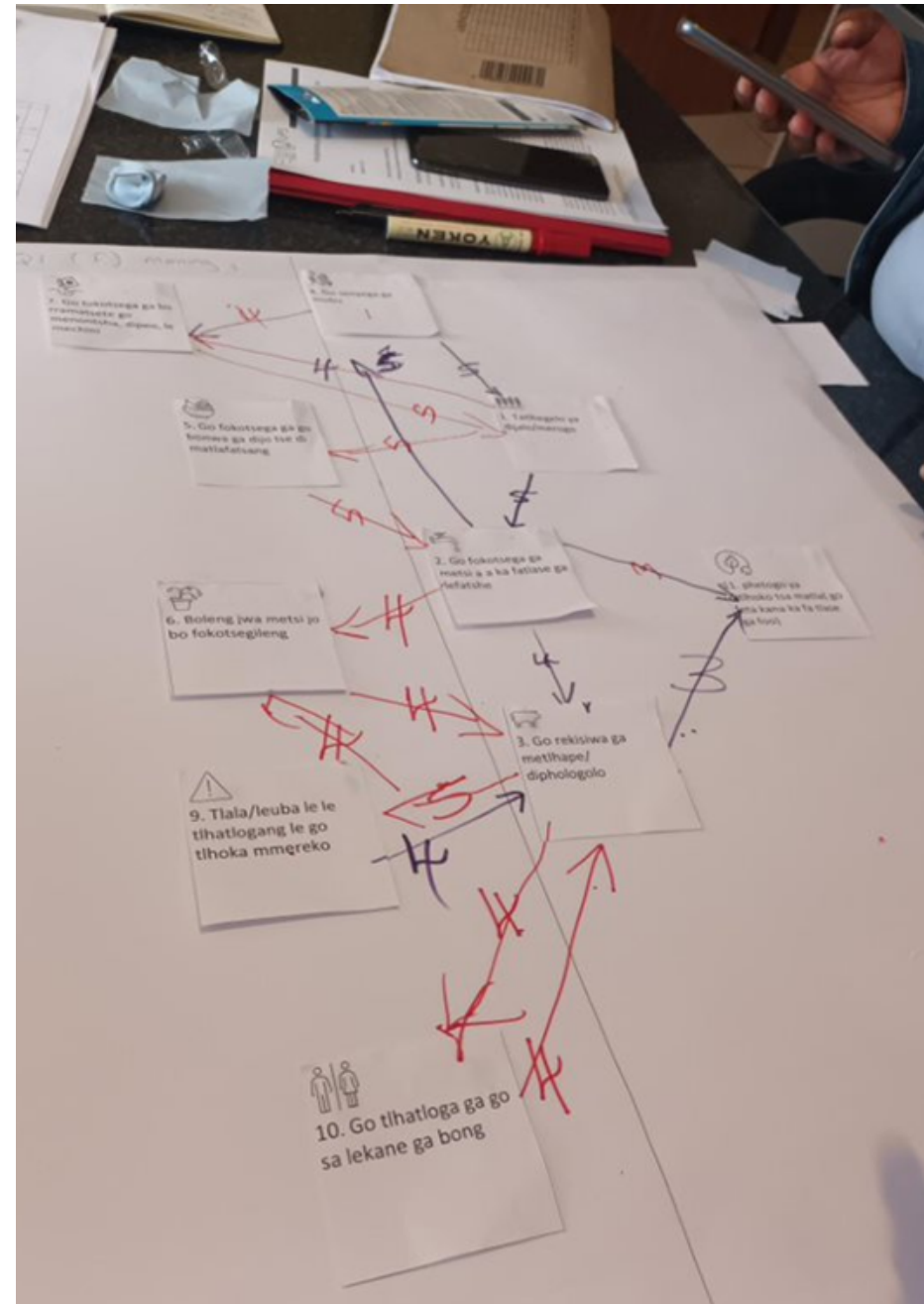
Example of a Developed Map



Component	Indegree	Outdegree	Centrality	Preferred State	Type
9	0.6	3.6	4.2		ordinary
1	0.6	2.2	2.8000000000000003		ordinary
2	1	1.2	2.2		ordinary
Extra 2	0.8	0.6	1.4		ordinary
8	0.8	0	0.8		receiver
3	0.8	0	0.8		receiver
Extra 3	0.6	0	0.6		receiver
Extra 1	0.6	0	0.6		receiver
11	0.6	0	0.6		receiver
7	0.6	0	0.6		receiver
6	0.6	0	0.6		receiver
5	0.6	0	0.6		receiver

Data Gathered

- Maps show how indicators are linked together
 - Indicators that are not used
 - New indicators that are added
- Also potential policy levers
 - Indicators with a lot of connections to other indicators (centrality)
 - Indicators at the start of a cascade of indicators (drivers)
- In addition the themes and discussions from the participants about their maps to help us understand their context



FCM in South Africa

- Workshop was conducted on one day in two different locations within the Free State of South Africa. There were two groups with below no. of participants:

Region 1 (n=8)	Region 2 (n=8)
Male = 5	Male = 3
Female = 3	Female = 5

- Male and female groups were separated to ensure comparison and so that all voices were heard and experiences captured
- Teams from Cranfield University and local collaborators from University of Free State tried to understand the farmers perspective towards drought risk and associated adaptation strategies



Findings in South Africa

- Per group 2 maps were drawn – 4 groups x 2 maps x 1 day = 8 maps
- Mental Modeler software used for the analysis
- Analysis done for – impacts of drought and adaptation to drought – maps compared based on location and gender
- New indicators added by farmers:
 - Price increase for animal feed
 - Wildfire
 - Animal diseases
 - Strain on relationship
 - Buy medicine and fodder for animals
 - Wind mills
 - Jojo tanks

	Top central indicators in Region 1		Top central indicators in Region 2	
	Male	Female	Male	Female
Q1 Impacts	1. Increasing poverty 2. Loss of crops (Livestock 4th)	1. Sale of livestock 2. Loss of crops (Increasing poverty 4th)	1. Increasing poverty 2. Loss of crops	1. Reduced water quality 2. Increasing poverty (Livestock 4th)
Q2 Adaptation	1. New technology 2. Water reuse (Govt. policy 3rd)	1. Drought resistant crops 2. New technology (Govt. policy 6th)	1. Govt. policies 2. Fertilisers and machinery (New tech highlighted)	1. Farming cooperatives 2. Govt. policies (New tech highlighted)

FCM in Morocco

- Workshop was conducted on two days in two different locations of Morocco – Settât and El Jadida
- Both the days had three groups with below no. of participants:

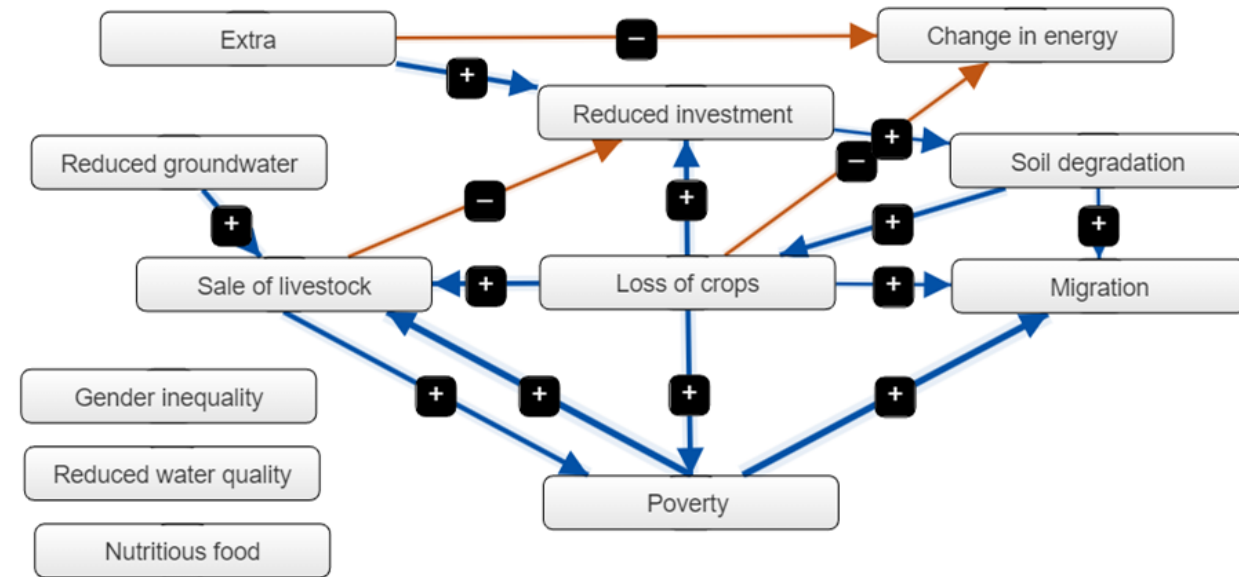
Settât (n=10)	El Jadida (n=16)
Male = 4 + 4	Male = 6 + 6
Female = 2	Female = 4

- Male and female groups were separated to ensure comparison and so that all voices were heard and experiences captured
- Teams from Cranfield University and local collaborators from University Mohammed VI Polytechnic (UM6P) tried to understand the farmers perspective towards drought risk and associated adaptation strategies
- Members from Al Moutmir, an NGO supporting farmers, were also present as facilitators



Findings in Morocco

- Per group two maps were drawn – 3 groups x 2 maps x 2 days = 12 maps
- Mental Modeler software used for the analysis
- Analysis done for – impacts of drought and adaptation to drought – maps compared based on location and gender
- New indicators added by farmers:
 - Increase in agricultural input prices
 - Sale of farms
 - Lack of precipitation
 - Participation in agricultural cooperatives
 - Helping small farmers to dig wells and access solar energy
 - Loan accumulation
 - Increase of cost of living
 - Creation of a product processing and marketing unit
 - Installation of a desalination unit and preservation of water resources
 - Exempting the farmer from paying loans in case of crop loss
 - Awareness through media and education
 - Promotion of Sprouted Barley for livestock feeding



E.g. of a map for impacts of droughts in Settat (Male group 2)

	Top two central indicators in Settat			Top two central indicators in El Jadida		
	Male 1 (Irrigated)	Male 2 (Rainfed)	Female (Irrigated)	Male 1 (Irrigated to rainfed)	Male 2 (Rainfed)	Female
Q1. Impacts	Loss of crops Reduced groundwater	Loss of crops Sale of livestock	Reduced groundwater Sale of livestock	Reduced groundwater Reduced water quality	Sale of livestock Reduced investment	Reduced groundwater Reduced water quality
Q2. Adaptation	Govt. policies New technology	Drought resistant crops New technology	Farming cooperative New technology	New technology Desalination unit	Govt. policies Drought resistant crops	Farming cooperative Fertilizers and machinery

Conclusion

- FCM used as a participatory method to explore experiences of drought and measures that support coping and adaptation
- Additional indicators added shows the importance of considering farmers perspective in decision making
- Importantly it allows (for the first time - to our knowledge) exploration of how those indicator link together
- This sheds new light on which indicators are 'important'. It may not be the indicator that is subjectively ranked highly by participants, it may be one that is central or driving other indicators. The maps may help us to find influence points
- Significant similarities and differences were noted with respect to location, gender, type of crops death with by the participating farmers – this will be useful in formulating context specific policies
- Interconnectivity between different drought indicators could be explored in other jurisdictions to look for contextual differences and commonality



Thank You

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